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**A METHOD AND SYSTEM FOR A MULTI-AXIS SCANNING
MODULE**

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A METHOD AND SYSTEM FOR A MULTI-AXIS SCANNING MODULE

CROSS REFERENCE TO RELATED APPLICATIONS

Reference is made to commonly-assigned copending U.S. Patent Application Serial No. 10/719,630, filed November 21, 2003, entitled

5 INTEGRATED SCAN MODULE FOR A COMPUTER RADIOGRAPHY INPUT SCANNING SYSTEM, by Baek et al., the disclosure of which is incorporated herein.

FIELD OF THE INVENTION

The present invention relates in general to radiography and in particular to scanning a computer radiographic phosphor plate having a latent image to generate a digital image file by means of a scanning device having a minor sub scanning axis to allow swath scanning using a single light source.

BACKGROUND OF THE INVENTION

In a photo-stimulatable phosphor imaging system, as described in U.S. Patent No. RE 31,847, a photo-stimulatable phosphor sheet is exposed to an image wise pattern of short wavelength radiation, such as x-radiation, to record a latent image pattern in the photo-stimulatable phosphor sheet. The latent image is read out by stimulating the phosphor with a relatively long wavelength stimulating radiation such as red or infrared light. Upon stimulation, the photo-stimulatable phosphor releases emitted radiation of an intermediate wavelength such as blue or violet light in proportion to the quantity of short wavelength radiation that was received. To produce a signal useful in electronic image processing, the photo-stimulatable phosphor sheet is scanned in a raster pattern by a beam of light produced for example by a laser deflected by an oscillating or rotating scanning mirror and the emitted radiation is sensed by a photo-detector such as a photomultiplier tube to produce the electronic image signal.

In one type of scanning apparatus, the photo-stimulatable phosphor sheet is placed on a translation stage and is translated in a page scan direction past a laser beam that is repeatedly deflected in a line scan direction to form the scanning raster.

To optimize the signal-to-noise ratio (S/N) of the imaging system, it is desirable to collect as much of the emitted light as possible and to direct it to

the photo-detector. While the apparatus employed to collect the light may take various forms, one form of light collector is proposed in U.S. Patent No. 4,346,295. The light collector proposed by U.S. Patent No. 4,346,295 comprises a sheet of light transmitting material that is flat on one end, and rolled into an 5 annular shape on the opposite end. The flat end of the light collector is positioned adjacent the scan line on the photo-stimulatable phosphor sheet. The light receiving face of a photomultiplier tube is placed against the annular end of the light collector.

Light emitted from the phosphor sheet enters the flat end of the 10 light collector and is light piped to the photomultiplier tube. Improved light collection efficiencies are achieved by having two such light collectors, one on each side of the scan line, or by placing a long narrow reflector opposite the flat end of the light collector to increase the collection window of the light collector. The transparent light collector has the drawback that it is inherently complicated 15 to manufacture. Furthermore, the collection efficiency of transparent light guides is limited due to their absorption in the wavelength range of light emitted by the photo-stimulatable phosphor sheet (e.g. blue-violet).

Experiments have identified another factor that limits the signal-to-noise ratio achievable with the photo-stimulatable phosphor imaging apparatus. 20 As the stimulating radiation beam scans the photo-stimulatable phosphor sheet, a high percentage (up to 90%) of the stimulating radiation is reflected from the photo-stimulatable phosphor. If this reflected stimulating radiation is further reflected back on to the surface of the photo-stimulatable phosphor (it is then called "flare") in a location away from the instantaneous scanning point, the 25 phosphor will be stimulated to emit in these other locations. When this flare induced emission of light is collected by the light collector it is called pre-stimulation and results in a spurious background signal. Such reflection of the stimulating radiation onto the photo-stimulatable phosphor may occur from the light collecting edge of the light guide described above. Examples of the image 30 degradation caused by pre-stimulation include a reduction in the contrast of images due to flare induced emission from high exposure areas. This adds unwanted signal to low exposure areas. Shadow artifacts are produced in the

image when a high exposure object on a low exposure background field is scanned. The signal-to-noise ratio in all image areas is degraded. Laser noise is enhanced since a large area of the phosphor is exposed to a low level of stimulating radiation, the light emitted from this area will follow the fluctuations in laser power, thereby amplifying the effect of the laser noise.

It is therefore the object of the present invention to provide a light collector having improved collection efficiency and one that is easy to manufacture.

SUMMARY OF THE INVENTION

10 Briefly, according to one aspect of the present invention a multi-axis scanning module for emitting light to and collecting light from a photo-stimulatable radiographic media comprises a housing moveable on a first axis relative to a radiographic media. A laser is disposed in a channel to generate a beam of stimulating electromagnetic radiation through the channel and out of the
15 first opening to stimulate an area on the radiographic media. A filter passes only light emitted from the area, wherein the filter is disposed between a center chamber and a second opening. A light detector disposes adjacent the filter in the second opening. The multi-axis scanning module is adapted to move transitionally on the first axis while the laser is modulated on a second axis
20 relative to the first axis to enable swath scanning of the radiographic media and production of an electronic signal.

The invention and its objects and advantages will become more apparent in the detailed description of the preferred embodiment presented below.

BRIEF DESCRIPTION OF THE DRAWINGS

25 While the specification concludes with claims particularly pointing out and distinctly claiming the subject matter of the present invention, it is believed that the invention will be better understood from the following description when taken in conjunction with accompanying drawings.

Figure 1 shows a schematic side view of a scanning module;
30 Figure 2 shows a schematic plan view of the multi-axis media scan
Figure 3 shows a perspective view of the multi-axis scanning module with radiographic media externally mounted adjacent a drum;

DETAILED DESCRIPTION OF THE INVENTION

The present invention will be directed in particular to elements forming part of, or in cooperation more directly with the apparatus in accordance with the present invention. It is to be understood that elements not specifically shown or described may take various forms well known to those skilled in the art.

Referring to Figure 1 a multi-axis scanning module 20 for providing electromagnetic radiation to and collecting emitted light 34 and reflected light 36 wherein the collection efficiency of the multi-axis scanning module 20 is approximately 52% from a photo-stimulatable radiographic media 28 such as selected from the group, a radiographic screen, a radiographic plate, a radiographic sheet, and or combinations thereof. The multi-axis scanning module 20 is adapted to move transitionally on a first axis 22 while a laser 18 emits a laser beam 19 of light and is dithered between 1 millimeter and 3 millimeters, preferably 1.5 millimeters, at an approximate rate 16k Hertz using a device such as a gavel mirror or a piezo transducer on a second axis 24 relative to the first axis 22 to enable swath 40 to scan the radiographic media 28 as shown in Figure 2, as the swath 40 is scanned at an angle of approximately six degrees relative to the first axis a motion corrected swath 42 is generated.

The a multi-axis scanning module 20 of Figure 1 comprises a housing 10 composed of materials such as plastic, a polycarbonate, a composite, a metal material or combinations thereof preferably of a molded construction, but is not limited to, and is moveable on a first axis 22 relative to the radiographic media 28 wherein the housing 10 comprises an ellipsoid chamber 25 having a reflective surface 26 that can be mirror coated reflective surface 26 with a reflectivity range of 80 % to 95% with diameter of 15 mm to 23 mm, preferably 20 mm, and a length that creates as an ellipsoid with a surface that matches the following formula:

$$(x^2/9.64372) + (y^2/9.64372) + ((z-11)^2/172) = 1$$

A channel 12 transmits a laser beam 19 that is in communication with the ellipsoid chamber 25 and wherein the laser 18 is preferably a Hitachi single mode 635nm, 35mw laser or a multi mode 635nm, 100mw laser. A first opening 14 communicates with the ellipsoid chamber 25 adapted for permitting the

electromagnetic radiation to pass out of the ellipsoid chamber 25 and the emitted light 34 and the reflected light 36 to be gathered in the ellipsoid chamber 25. A second opening 16 communicates with the ellipsoid chamber 25. The laser 18 is disposed in the channel 12 to generate the laser beam 19 of electromagnetic
5 radiation through the channel 12 and out the first opening 14 to generate a stimulated area 38 on the radiographic media 28, wherein the ellipsoid chamber 25 is adapted to receive emitted light 34 and reflected light 36 from the stimulated area 38 on the radiographic media 28. A filter 32, preferably blue, which may have an antireflective coating on at least one surface is disposed between the
10 ellipsoid chamber 25 and the second opening 16. The filter 32 may be a Hoya 390 or B 410 from Hoya of Tokyo, Japan or alternatively a Schott BG -1 or BG 3 filter available from Schott of Mainz, Germany and is used to selectively pass only the emitted light 34 from the stimulated area 38 on the radiographic image 28 to a light detector 30 disposed adjacent the filter 32 in the second opening 16 for
15 detecting the emitted light 34. The light detector 30, such as a PMT photomultiplier by Hamamatsu type R7400U available from Hamamatsu of Japan, receives the emitted light 34 and generates a signal 58. The signal 58 is transmitted to an analog to digital converter 54 to provide a digital signal 48. The digital signal 48 is then compiled and stored as a digital image in a control-
20 processing unit 52, such as a computer. The digital image can then be processed depending on the needs of the user. For example, the digital image can be printed on an output device 56 such as a black and white x-ray film using a film writer or a soft display on a monitor. An example of a usable film writer in the system of the invention is a Kodak Drive U Imager 850 available from Eastman Kodak
25 Company of Rochester, New York.

Figure 3 shows a multi-axis system scans radiographic media using a multi-axis swath scanning technique comprising at least one multi-axis scanning module 20 mounted on a translation stage 64 adapted for movement along axis 61 supported by translation rods 66a and 66b adjacent the radiographic media 28
30 mounted on a rotating drum 60 adapted for rotation about central axis 68 in a counter clockwise direction 70. As shown in Figure 1 the multi-axis scanning module 20 comprises a housing 10 moveable on a first axis relative to the

radiographic media 28 wherein the housing 10 comprises an ellipsoid reflective chamber 25; a channel 12 for transmitting a laser beam 19 in communication with the ellipsoid reflective chamber 25; a first opening 14 in communication with the ellipsoid reflective chamber 25 adapted for permitting light to pass out of the
5 ellipsoid reflective chamber 25 and light to be gathered in the ellipsoid reflective chamber 25; and a second opening 16 in communication with the ellipsoid reflective chamber 25. The laser 18 is disposed in the channel 12 to generate a laser beam 19 of stimulating electromagnetic radiation through a collimator lens 50 that can be dithered and through the channel 12 and out the first opening 14 to
10 generate a stimulated area 38 on the radiographic media 28. A filter 32 passes only emitted light 34 from the stimulated area 38, wherein the filter 32 is disposed between the ellipsoid reflective chamber 25 and the second opening 16. A light detector 30 disposed adjacent the filter 32 in the second opening 16 detects the emitted light 34. The multi-axis scanning module 20 is adapted to move
15 transitionally on the first axis 22 while the laser 18 or the laser beam 19 is dithered on a second axis 24 relative to the first axis 22 to enable swath scanning of the radiographic media 28 and production of a signal 58. An analog to digital converter 54 communicates with the light detector 30 and the control processing unit 52 communicates with the analog to digital converter 54 for receiving,
20 storing, and processing the digital signal 48. An output device 56 outputs the digital signal 48.

The invention has been described in detail with particular reference to certain preferred embodiments thereof, but it will be understood that variations and modifications can be effected within the scope of the invention.

PARTS LIST

- 10 housing
- 12 channel
- 14 first opening
- 16 second opening
- 18 laser
- 19 laser beam
- 20 multi-axis scanning module
- 22 first axis
- 24 second axis
- 25 ellipsoid chamber
- 26 reflective surface
- 28 radiographic media
- 30 light detector
- 32 filter
- 34 emitted light
- 36 reflected light
- 38 stimulated area
- 40 swath
- 42 motion corrected swath
- 48 digital signal
- 50 collimator lens
- 52 control processing unit
- 54 analog to digital converter
- 56 output device
- 58 signal
- 60 rotating drum
- 61 axis
- 64 translation stage
- 66a translation rod
- 66b translation rod
- 68 central axis

70 clockwise direction